

CLAIMS

WE CLAIM:

1. A method comprising:

forming a solution-A comprising precursor (A) and a first solvent;

forming a mixture-B comprising precursor (B) and a second solvent;

forming a hot solution-B by heating mixture-B to a predetermined temperature greater than the temperature of solution-A;

forming a synthesis mixture by injecting solution-A into hot solution-B;

forming semiconductor nanocrystals in the synthesis mixture;

quenching the synthesis mixture.

2. The method of claim 1 wherein the synthesis mixture is quenched by adding a relatively cool volume of a quench solvent.

3. The method of claim 2 wherein the quench solvent is the second solvent.

4. The method of claim 2 wherein the quench solvent is selected from the group consisting of heat transfer fluids, alkylated aromatics, aryl ethers, isomers of alkylated aromatics, alkyl benzenes, Dowtherm A (DTA), biphenyl (BP), phenyl ether (PE), Dowtherm G, Dowtherm RP, Dowtherm Q, Dowtherm J, Dowtherm HT, Dowtherm T, Dowtherm MX, terphenyls, and combinations thereof.

5. The method of claim 4 wherein precursor (A) is selected from the group consisting of Se, trioctylphosphine selenide (TOPSe), Te, S, As, Sb, and combinations thereof.

6. The method of claim 4 wherein precursor (B) is selected from the group consisting of oxides and other salts of Cd, Pb, Zn, Ga, In, and combinations thereof.

7. The method of claim 5 wherein precursor (A) is selected from the group consisting of Se, trioctylphosphine selenide (TOPSe), and combinations thereof, and the first solvent comprises trioctylphosphine (TOP).

8. The method of claim 7 wherein precursor (B) is selected from the group consisting of cadmium oxide, other cadmium salts, and combinations thereof.

9. The method of claim 8 wherein mixture-B further comprises oleic acid (OA).

10. The method of claim 5 wherein the second solvent is selected from the group consisting of Dowtherm A (DTA), biphenyl (BP), phenyl ether (PE), triphenyls, and combinations thereof.

11. The method of claim 10 wherein the second solvent is selected from the group consisting of Dowtherm A (DTA), biphenyl (BP), phenyl ether (PE), and combinations thereof.

12. The method of claim 11 wherein the second solvent is Dowtherm A (DTA).

- 5 13. The method of claim 4 further comprising:
injecting additional precursor (A) into the quenched synthesis mixture.
14. The method of claim 4 further comprising:
injecting additional precursor (B) into the quenched synthesis mixture.
15. The method of claim 13 further comprising:
10 injecting additional precursor (B) into the quenched synthesis mixture.
16. The method of claim 4 further comprising:
reheating the quenched synthesis mixture.
17. A method comprising:
forming a solution-A/B comprising precursor (A) and precursor (B);
15 forming a synthesis mixture by injecting solution-A/B into a hot solvent;
forming semiconductor nanocrystals in the synthesis mixture;
quenching the synthesis mixture by adding a relatively cool volume of the solvent.
18. The method of claim 17 wherein the solvent is selected from the group consisting of heat transfer fluids, alkylated aromatics, aryl ethers, isomers of alkylated aromatics, alkyl
20 benzenes, Dowtherm A (DTA), biphenyl (BP), phenyl ether (PE), Dowtherm G, Dowtherm RP, Dowtherm Q, Dowtherm J, Dowtherm HT, Dowtherm T, Dowtherm MX, terphenyls, and combinations thereof.
19. The method of claim 18 wherein precursor (A) is selected from the group consisting of Se, trioctylphosphine selenide (TOPSe), and combinations thereof, and precursor (B) is
25 selected from the group consisting of cadmium oxide, other cadmium salts, and combinations thereof.
20. The method of claim 19 wherein solution-A/B further comprises oleic acid (OA).
21. The method of claim 19 further comprising reheating the quenched synthesis mixture.
22. The method of claim 19 wherein the solvent is selected from the group consisting of
30 Dowtherm A (DTA), biphenyl (BP), phenyl ether (PE), triphenyls, and combinations thereof.
23. The method of claim 19 wherein the solvent is selected from the group consisting of Dowtherm A (DTA), biphenyl (BP), phenyl ether (PE), and combinations thereof.
24. A method for making semiconductor nanocrystals, comprising:
a) dissolving a precursor of a desired element in a first solvent to form a precursor
35 solution;
b) mixing a metal oxide with a second solvent to form mixture;
c) heating the mixture to a predetermined temperature; and
d) injecting the precursor solution into the heated mixture to form a growth solution.

- 5 25. The method according to claim 24 wherein the second solvent comprises Dowtherm A fluid (or phenyl ether or biphenyl).
26. The method according to claim 25 wherein the second solvent further comprises oleic acid (OA).
27. The method according to claim 24 wherein the second solvent is at room temperature.
- 10 28. The method according to claim 24 wherein the precursor solution comprises a molar ratio of the desired element to the first solvent of 1/300.
29. The method according to claim 24 wherein the precursor solution comprises a molar ratio of the desired element to oleic acid in the range of from 1/10 to 1/1, inclusive.
30. The method according to claim 29 wherein the precursor solution comprises a molar ratio
15 of the desired element to oleic acid of 1/3.
31. The method according to claim 24 wherein step c) comprises heating the solution to at least 250°C under vigorous stirring for 30 minutes or until the solution clears.
32. The method according to claim 24 wherein the precursor solution is injected into the heated mixture in less than 2 seconds.
- 20 33. The method according to claim 24 wherein the precursor solution is injected into the heated mixture in less than 1 second.
34. The method according to claim 24 wherein the injection temperature is between about 220 and 260°C
35. The method according to claim 24 wherein the precursor is Cd.
- 25 36. The method according to claim 24 wherein step a) comprises dissolving selenium powder in trioctylphosphine (TOP) (Se/TOP = 1/8 molar ratio).
37. The method according to claim 24, further comprising the step of
e) quenching the growth solution.
38. The method according to claim 37 wherein step e) comprises cooling the growth solution
30 to less than 200°C.
39. The method according to claim 37 wherein step e) comprises cooling the growth solution to less than 150°C.
40. The method according to claim 37 wherein step e) comprises cooling the growth solution to less than 120°C.
- 35 41. The method according to claim 37, further comprising the step of
f) re-heating the quenched growth solution.
42. The method according to claim 41 wherein step e) comprises re-heating the growth solution to at least 120°C.

- 5 43. The method according to claim 41 wherein step e) comprises re-heating the growth solution to at least 150°C.
44. The method according to claim 24 wherein the second solvent is selected from the group consisting of heat transfer fluids, alkylated aromatics, aryl ethers, isomers of alkylated aromatics, alkyl benzenes, Dowtherm G, Dowtherm RP, Dowtherm Q, Dowtherm J,
10 Dowtherm HT, Dowtherm T, and Dowtherm MX.
45. The method according to claim 24 wherein the second solvent is selected from the group consisting of inorganic solvents, silicone oil, related siloxane compounds having a molecular backbone of Si-O-Si bonds, and fluorinated solvents.
46. The method according to claim 24 wherein the second solvent comprises a phenylated
15 compound.